SOME TYPICAL COMMERCIAL REAGENT SOLUTIONS

Reagent (• strong acids)	Formula	Concentration (mol/L)	Concentration (mass %)
acetic acid	$CH_3COOH(aq)$	17.4	99.5
ammonia	$NH_3(aq)$	14.8	28
carbonic acid	$H_2CO_3(aq)$	0.039	0.17
• hydrochloric acid	$HCl(aq)$	11.6	36
• nitric acid	$HNO_3(aq)$	15.4	69
phosphoric acid	$H_3PO_4(aq)$	14.6	85
sodium hydroxide	$NaOH(aq)$	19.1	50
sulfurous acid	$H_2SO_3(aq)$	0.73	6
• sulfuric acid	$H_2SO_4(aq)$	17.8	95

SELECTED SI PREFIXES

Prefix	Symbol	Factor
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

DEFINED (EXACT) QUANTITIES

1 t	=	1000 kg = 1 Mg
STP	=	0 °C and 101.325 kPa (use 0 °C and 101 kPa)
SATP	=	25 °C and 100 kPa
0 °C	=	273.15 K (use 273 K)
1 atm	=	101.325 kPa (use 101 kPa)
1 atm	=	760 mm Hg
1 bar	=	100 kPa

MEASURED (UNCERTAIN) QUANTITIES

N_A	=	6.02×10^{23}/mol
R	=	8.314 kPa • L/(mol • K)
F	=	9.65×10^{4} C/mol
K_w	=	1.0×10^{-14}
c (in a vacuum)	=	3.00×10^{8} m/s
V_{STP}	=	22.4 L/mol
V_{SATP}	=	24.8 L/mol
d_{H_2O}	=	1.00 g/mL

SOME COMMON ACID–BASE INDICATORS

Common name of indicator	Suggested symbol	Colour of HIn(aq)	pH range of colour change	Colour of $In^-(aq)$	K_a
methyl violet	HMv	yellow	0.0 - 1.6	blue	$\sim 10^{-1}$
cresol red	H_2Cr	red	0.0 - 1.0	yellow	$\sim 10^{-1}$
thymol blue	H_2Tb	red	1.2 - 2.8	yellow	2.2×10^{-2}
orange IV	HOr	red	1.4 - 2.8	yellow	$\sim 10^{-2}$
benzopurpurine-48	HBp	violet	2.2 - 4.2	red	$\sim 10^{-3}$
congo red	HCo	blue	3.0 - 5.0	red	$\sim 10^{-4}$
methyl orange	HMo	red	3.2 - 4.4	yellow	3.5×10^{-4}
bromocresol green	HBg	yellow	3.8 - 5.4	blue	1.3×10^{-5}
methyl red	HMr	red	4.8 - 6.0	yellow	1.0×10^{-5}
chlorophenol red	HCh	yellow	5.2 - 6.8	red	5.6×10^{-7}
bromothymol blue	HBb	yellow	6.0 - 7.6	blue	5.0×10^{-8}
litmus	HLt	red	6.0 - 8.0	blue	$\sim 10^{-7}$
phenol red	HPr	yellow	6.6 - 8.0	red	1.0×10^{-8}
cresol red	HCr^-	yellow	7.0 - 8.8	red	3.5×10^{-9}
metacresol purple	HMp	yellow	7.4 - 9.0	purple	$\sim 10^{-8}$
thymol blue	HTb^-	yellow	8.0 - 9.6	blue	6.3×10^{-10}
phenolphthalein	HPh	colourless	8.2 - 10.0	red	3.2×10^{-10}
thymolphthalein	HTh	colourless	9.4 - 10.6	blue	1.0×10^{-10}
alizarin yellow R	HAy	yellow	10.1 - 12.0	red	6.9×10^{-12}
indigo carmine	HIc	blue	11.4 - 13.0	yellow	$\sim 10^{-12}$
1,3,5-trinitrobenzene	HNb	colourless	12.0 - 14.0	orange	$\sim 10^{-13}$

COMMON POLYATOMIC IONS— THEORETICAL SUMMARY

• acetate	CH_3COO^-	dihydrogen phosphate	$H_2PO_4^-$	hydrogen sulfite (bisulfite)	HSO_3^-	persulfide	S_2^{2-}
• ammonium	NH_4^+	glutamate	$C_5H_8NO_4^-$	hydronium	H_3O^+	• phosphate	PO_4^{3-}
benzoate	$C_6H_5COO^-$	• hydrogen carbonate (bicarbonate)	HCO_3^-	• hydroxide	OH^-	silicate	SiO_3^{2-}
borate	BO_3^{3-}	hydrogen oxalate	$HOOCCOO^-$	• hypochlorite	ClO^-; OCl^-	stearate	$C_{17}H_{35}COO^-$
carbide	C_2^{2-}	hydrogen phosphate	HPO_4^{2-}	mercury(I)	Hg_2^{2+}	• sulfate	SO_4^{2-}
• carbonate	CO_3^{2-}	• hydrogen sulfate (bisulfate)	HSO_4^-	• nitrate	NO_3^-	sulfite	SO_3^{2-}
chlorate*	ClO_3^-	hydrogen sulfide	HS^-	nitrite	NO_2^-	tetraborate	$B_4O_7^{2-}$
chlorite	ClO_2^-			oxalate	$OOCCOO^{2-}$	thiocyanate	SCN^-
chromate	CrO_4^{2-}			perchlorate*	ClO_4^-	thiosulfate	$S_2O_3^{2-}$
citrate	$C_3H_4OH(COO)_3^{3-}$			• permanganate	MnO_4^-	tripolyphosphate	$P_3O_{10}^{5-}$
cyanide	CN^-			peroxide	O_2^{2-}		
• dichromate	$Cr_2O_7^{2-}$						

• Frequently used ions

*There are also corresponding ions containing Br and I instead of Cl.

SOLUBILITY OF IONIC COMPOUNDS AT SATP—GENERALIZATIONS*

Ion	Cl^- Br^- I^-	S^{2-}	OH^-	SO_4^{2-}	CO_3^{2-} PO_4^{3-} SO_3^{2-}	CH_3COO^-	NO_3^- ClO_3^- ClO_4^-	Group 1 NH_4^+ H_3O^+ (H^+)
Very soluble (aq) $\geq$ 0.1 mol/L	most	Group 1, NH_4^+, Group 2	Group 1, NH_4^+, Sr^{2+}, Ba^{2+}, Tl^+	most	Group 1, NH_4^+	most	all	all
Slightly soluble (s) $<$ 0.1 mol/L (at SATP)	Ag^+, Pb^{2+}, Tl^+, Hg_2^{2+}, Cu^+	most	most	Ag^+, Pb^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Ra^{2+}	most	Ag^+, Hg_2^{2+}	none	none

*Although these are particularly reliable, all generalizations have exceptions. This textbook specifically identifies any reference to an ionic compound solubility that is an exception to these generalizations.

SELECTED ION COLOURS

Ion	Solution colour (1.0 mol/L)	Solution colour (0.010 mol/L)	Ion	Flame colour
Groups 1, 2, 17	colourless	colourless	Li^+	bright red
Cr^{2+}	dark blue	pale blue	Na^+	bright yellow
Cr^{3+}	blue-green	green	K^+	violet
Co^{2+}	red	pink	Rb^+	violet
Cu^+	blue-green	pale blue-green	Cs^+	violet
Cu^{2+}	blue	pale blue		
Fe^{2+}	pale green	colourless	Ca^{2+}	yellow-red
Fe^{3+}	yellow-brown	pale yellow	Sr^{2+}	bright red
Mn^{2+}	pale pink	colourless	Ba^{2+}	yellow-green
Ni^{2+}	blue-green	pale green	Cu^{2+}	blue-green
CrO_4^{2-}	yellow	pale yellow		
$Cr_2O_7^{2-}$	orange	pale orange	Pb^{2+}	light blue-grey
MnO_4^-	deep purple	purple-pink	Zn^{2+}	whitish-green